

Title: Problem Solving, Pattern Building

Link to Outcomes:

- **Problem Solving** Students will demonstrate their ability to solve problems in mathematics including problems with open-ended answers, problems which are solved in a cooperative atmosphere, and problems which are solved with the use of technology.
- **Communication** Students will demonstrate their ability to communicate mathematically. They will read, write, and discuss mathematics with language, signs, symbols, and terms of the discipline.
- **Reasoning** Students will be able to demonstrate their ability to reason mathematically. They will make conjectures, gather evidence, and build arguments.
- **Patterns and Relationships** Students will demonstrate their ability to recognize numeric and geometric relationships and will generalize a relationship from data.

Brief Overview:

This activity helps students explore the relationships of patterns. Students will learn how to use a table to help investigate a pattern in an organized and systematic way. Students will examine patterns in order to make conjectures about relationships when solving problems.

Grade/Level:

Grade 4 (2nd half of academic year) / Grade 5 (1st half of academic year)

Duration/Length:

This lesson will take five to ten 45-minute periods of “intense” patterning work.

Prerequisite Knowledge:

The student should have a basic understanding of

- copying a concrete pattern
- extending a concrete pattern

Objectives:

- Identify core of a repeating pattern.
- Use the core of a repeating pattern to duplicate and extend a pattern.
- Use a table to explore patterns.
- Determine rule for a simple growing pattern.

Materials/Resources/Printed Materials:

- Sentence strips
- Pattern blocks
- Toothpicks
- Containers to hold pattern blocks for each group
- Chart paper
- Overhead transparencies/pens

Bibliography:

A "Hands On" Approach to Teaching Pattern and Function, Brisby, Linda Sue, et. al, Hands On, Inc., Solvang, CA, 1990
The Pattern Factory, Roper, Ann and Harvey, Linda, Ideal School Supply Company, Oak Lawn, Ill, 1993
Elementary School Mathematics: Teaching Developmentally, Van de Walle, John A., Longman, White Plains, NY, 1994

Lesson 1:

Warm-up: Begin with repeated motion patterns. Do several.

Example: snap fingers, clap hands twice (children copy)*

Call up one student, then 2 students, then 3 students, etc. Have them remain in line in their groups as called. Discuss the pattern needed to extend this student line.

* Extension: (cross-curricular-music) Use a variety of hand-clap patterns throughout the year to bring class to order.

Procedure/Development:

- Call up one student. Elicit number of eyes. Call up a second student. Elicit total number of eyes now. Continue this for five students. Without calling the sixth student, have class predict the number of eyes. Do this until they feel comfortable with predicting the number of eyes for a particular number of students. Elicit the pattern they are using to get this prediction. (x2)

- With pattern blocks, ask students to copy pattern you start, then have them extend this pattern (examples below). Ask students what is repeating in each pattern. Define this as the “core.” Do several of these (Hint: These could be put on sentence strips).



core of 2 - A-B



core of 3 - A-A-B



core of 4 - A-B-B-A

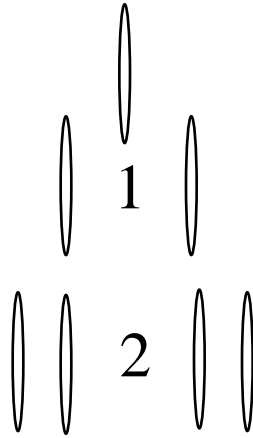
- Work with students to develop the patterning behind the “core.” For example, in the first example, the core pattern is A - B - A - B.
- At this point build another pattern with a different concrete material that uses the pattern A - B - A - B.
- Identify the core pattern in example three above as A - B - B - A. At this point call up another student to build an A - B - B - A core with another medium. Continue calling up students to show different core patterns. (For example: A - A - B, A - B - C, etc.)
- Build several repeating patterns using different mediums and differing core lengths and ask students to identify the core pattern.
- Closure/Journal Ask students to use pattern blocks to build a core of a pattern to be repeated. Then record by tracing, coloring, and labeling two different patterns in their journals. (Note: Students may record on their sentence strips and place a pattern label on the back. These could be used later at a center for “core” identification.)
- Try the PS PB Core Challenge - see Student Resource 1

Lesson 2:

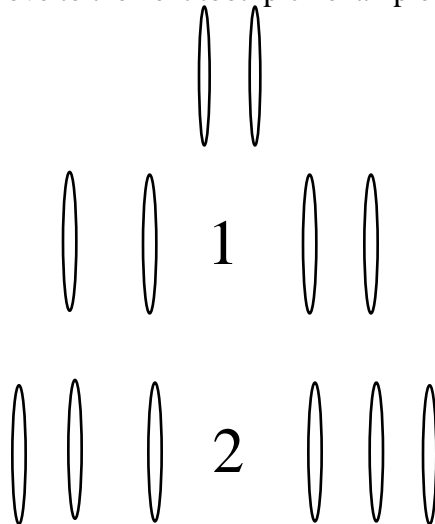
Warm Up: Review core identification by using some of the student-developed examples from previous day.

Procedure/Development:

- Use toothpicks to place following pattern on overhead:
[**Management Hint:** Break toothpick in half to allow all patterning to fit on overhead surface.]



- Elicit from class the next step in this pattern. Ask how students arrived at their predictions, then move to the next toothpick example below.



- Elicit from students how they would decide the next one in this pattern. Using toothpicks, ask them to generate the third term. This differs from the previous example and can be used as a lead in to patterns that are not readily discernible, yet are still predictable. (Note that the pattern is extended by examining the previous term.)

- Give students a simple numeric pattern such as 2,4,6,8,... Ask the students to identify and extend the pattern.
- Ask the students how they determined the next number in the sequence.
- Develop the vocabulary word “term” as you demonstrate placing each number from the pattern into table form.

<u>Term number</u>	<u>Number from pattern</u>
1	2
2	4
3	6
4	?
.	
.	
.	

- Work through determining such problems as, “What is the seventh term, tenth term, etc.?” Use table to record and to show how the “rule” can be used to determine subsequent terms and ultimately the *nth* term (*nth* term means any unknown term).
- Repeat table development with progressively harder numerical patterns such as:




4, 8, 12, 16, ... (*nth* term is generated by 4 X the term number)

5, 10, 15, 20, ... (*nth* term is generated by 5 X the term number)

- Using the Close Paragraph (Teacher Resource #1), ask the students to summarize the day’s activities in their journals.
- Enrichment: Put up following 1, 4, 7, 10, 13,... Have class continue pattern, then ask them for the tenth term. Ask how they determined the tenth term, then try, 15th & 20th and ask if they want to use the same method? If no one has tried table, demonstrate using a table to help with deciding the rule in order to generate any term you want.

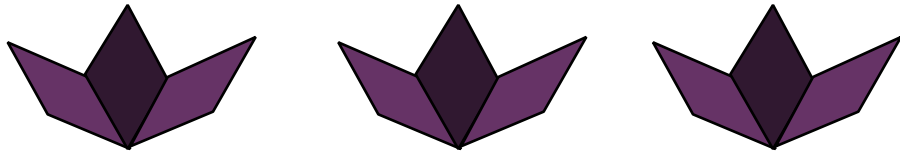
Lesson 3:

Warm-up: Present following problem:

<u>Term number</u>	<u>Number from pattern</u>	
1	3	 +3
2	6	 +3
3	9	 ?
4	?	
.		
.		
.		
<i>nth</i>	?	

Procedure/Development:

- Put one flower from the following on overhead (two tan one blue)



- Develop table as follows (Note transition from “term number to flower number.”):

<u>Flower number</u>	<u>Number of blocks</u>
1	3
2	6
3	9
4	?
.	
.	
.	
<i>nth</i>	?

- Ask the children to build a “sunflower” with their pattern blocks using the following description:

Place one (1) orange square surrounded by four (4) green triangles. Make sure that all sides are touching.

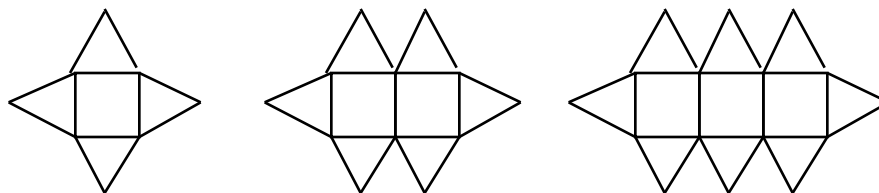
Together, on the overhead, develop an appropriate table for this example.

Now ask children to place two orange squares surrounded by six (6) green triangles.

- After the children have built their own at their desks, ask them to describe what they think the next one in the pattern would be.

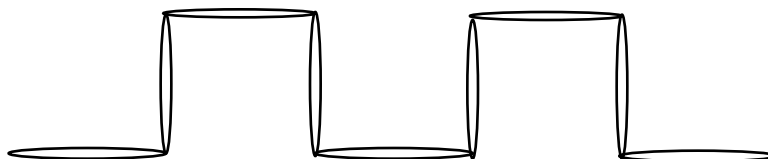
- Place appropriate information into the table on the overhead.

The sunflower and its table should look like this:



<u>squares</u>	<u>triangles</u>
1	4
2	6
3	8

- Ask class to share with you how many squares and how many triangles they would need to build the next one. Try to elicit (or just show) the +2 rule for getting the next triangle number in the table. However, this does not help you generate the *n*th term. Work through how you find the number of triangles if you only know the number of squares used. (Note: you would need to **multiply by 2 and +2.**)
- Pose the following toothpick pattern:



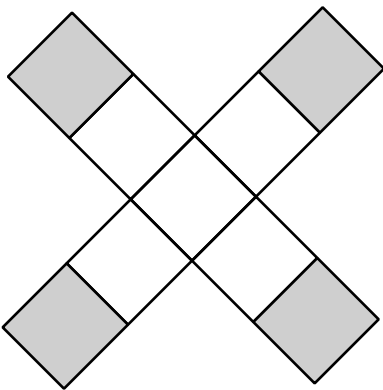
- Build a table to fit this problem.

tunnels	toothpicks needed
1	5
2	9
3	13

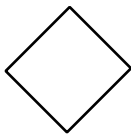
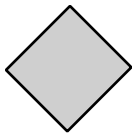
Help class to figure out the *n*th one, you would need to **multiply by 4 and +1.**

“Suppose we wanted 20 tunnels. How many toothpicks would we need?” Elicit from students how to use the table to help them determine the number of toothpicks needed (Note how table is labeled to fit the problem).

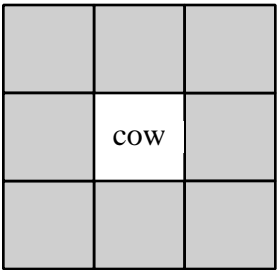
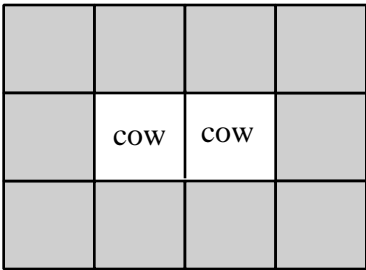
- After students are proficient in using the table to help them find successive terms, give problems like the following from page 36 of *The Pattern Factory* (The Ideal School Supply Company, 1993).



Windmill	Squares
1	5
2	9

 = the first set of squares
 = the second set of squares

Cows and Fences (p. 19, *The Pattern Family*)

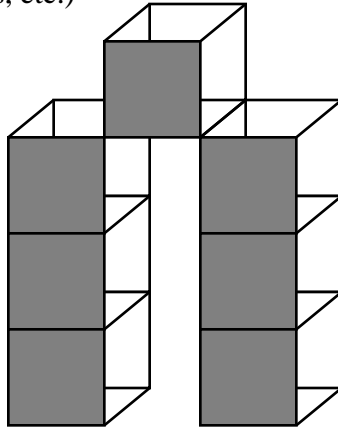



Cows	Cubes in Fence
1	8
2	10

Closure: Ask students to work with a partner. Select one pattern block to be the center piece. Select a second (different) pattern block to use to surround this center piece. Note the sides must be flush (NO POINT TO SIDE OR POINT TO POINT arrangements) See Resource Section for *Name Your Own Pattern* sheet, Student Resource 2.

Lesson 4:

Warm-up: This is an arch - (show this made with unifix cubes, rainbow cubes, or centimeter cubes, etc.)



This arch takes 7 cubes to build...build 2 arches that takes only 11 cubes...build 3 arches that takes 15 cubes.

Development/Procedure:

- Using Pattern Blocks, ask students to follow these written directions:

Use the hexagon pattern block as your center. Surround this piece with six trapezoids with the short sides of the trapezoid fitting flush to the sides of the hexagon.

Note: you can generate other “buildings” from verbal direction/written problems.

- Have problems below prepared ahead of time. Note: This activity can be done in cooperative groups. Assign each group one problem to solve. Give each a large sheet of paper to illustrate its solution. It must include HOW each group solved this problem and an appropriate illustration. These solutions will be shared and discussed together.
 1. Some classrooms have hexagon-shaped tables. One student can be seated at each side of the table (one table seats 6). If two hexagon tables are pushed together, ten students can be seated. Three hexagon tables will seat 16. Will seven tables pushed together (in a straight line) be enough to seat the 30 children in the class?

2. Caneb's Supermarket is having a special on dog food. For every six cans of canned dog food that you purchase, it will give your dog two dog bones. For every 12 cans of canned dog food you buy, it will give you four dog bones. For every 18 cans, you will get six bones. How many cans do you need to purchase to receive ten dog bones? 20 dog bones?
3. Matt went to Cal Ripken's Baseball Shop. For every seven old baseball cards he trades in, he will receive two new ones. If he has 42 cards to trade in, how many new cards will Matt have when he leaves Cal's shop?

Evaluation:

The teacher will evaluate by observation and by journal entries.

Extension/Follow Up:

- Use student generated patterns from **Lesson One** in center for pattern building.
- Start Pattern of the Week.
- Tie in calculator study, especially with constant function key, with pattern building.
- Use student designed patterns for borders on bulletin boards.
- Tie in with art lesson, for example tessellations.
- Puzzle/Pattern of the Week for whole school - primary & intermediate versions

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Directions:

Copy in your journal. Use the terms below to fill in the missing words.

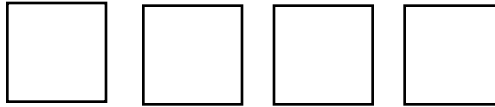
_____ can be drawn in a row that form a pattern. Numbers can be _____ in rows that form patterns. A _____ is one tool that can help find missing pictures or numbers in a pattern that repeats.

TABLE PICTURES WRITTEN

The PS PB Core Challenge!

Use the hexagon and the square to make a repeated pattern.
Use any core pattern you want, but it must have 4 members.
The blocks must be touching each other.
You may not change your pattern core once you select it.

Record your core pattern here.

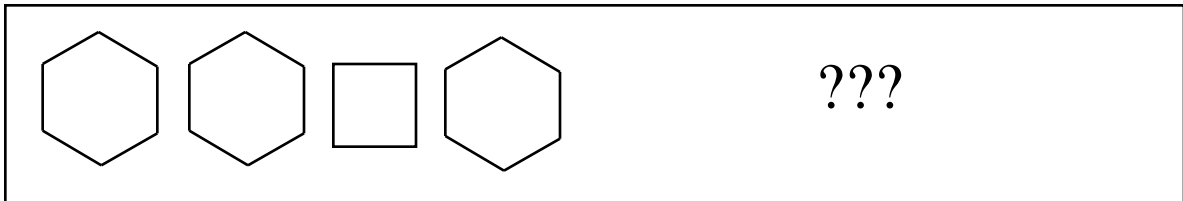


Estimate the number of core patterns it will take to cover an 18" sentence strip.*
Put your estimate in the box.



Cover the sentence strip with repeated core patterns.

The Challenge: Can you choose a core pattern that will completely cover the sentence strip and not extend over the edge or be too “short?”



We will measure to see whose core comes the closest to the end of the sentence strip (without going over!)

* In place of sentence strips, the width or length of the desk could be used.

Name Your Own Pattern

Directions: Use the space below to design your pattern using the following rules.

1. Choose one pattern block as the center piece.
2. Select a second (different) pattern block to use to surround this center piece.
3. Sides must be FLUSH!

We chose _____ as our center pattern block. We used the _____ to surround it.

"surround" number	total number of blocks
1	
2	
3	

A good name for our pattern is _____.